ASSESSING ACTIVITY OF FOSSORIAL RODENTS IN SOUTHERN MOROCCO

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Abstract: The closed-burrow method and trap success were examined as means for indexing burrowing rodent activity/abundance on nine 3-km^2 plots in a daghmous steppe area of southern Morocco. Three species of rodents were examined: Shaw's jird (*Meriones shawi*), Libyan jird (*M. libycus*) and the fat sand rat (*Psammomys obesus*). Sampling within the plots was conducted such that the assessment methods were not applied to the same animals and, therefore, would not influence one another. Trap success and closed burrow results did not correlate well. The closed-burrow method was concluded to be most efficiently applied when holes were reexamined after 24 hrs instead of 48 hrs after closure.

Key words: Closed-burrow, fat sand rat, jird, *Meriones*, population index, *Psammomys*, trap effort.

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INTRODUCTION

Fossorial animals are difficult to directly observe. Radio telemetry greatly assists the biologist in following an animal's activity; however, it requires an investment in specialized equipment, it can be difficult to simultaneously monitor a large number of animals without computerized tracking equipment, and it can be physically difficult to accomplish in rough terrain. The same difficulties hold true for other means of direct observation of fossorial animals, such as the use of video equipment. Indirect observations of animal sign, such as burrow opening, burrow closing, or tracking methods, reflect a combination of population characteristics; abundance and level of activity. Consequently, we refer indices generated from these observations as activity/abundance indices, rather than simply activity indices or abundance indices. In particular, an indirect assessment of an animal's burrow system for activity can be a valuable tool for the biologist, as a means to identify whether or not burrow systems are actively occupied, can be used to make relative inferences about burrow systems in different areas or to monitor changes within a given area.

Varying degrees of success in estimating the activity/abundance have been obtained among observational methods and among species for North American fossorial mammals. For example, mound counts (e.g. Anthony and Barnes 1983) and the open-hole method (Richens 1967, Barnes et al. 1970) have been regularly applied for assessing activity of northern pocket gophers (*Thomomys talpoides*). A direct comparison of the two methods indicated that the open-hole method was substantially more sensitive as a measure and could reliably be used to assess activity within gopher burrow systems (Engeman et al. 1993). This activity assessment method for burrow systems has performed well for monitoring changes in population abundance. However, when the same method was applied to Townsend's pocket gophers (*T. townsendii*), it did not reflect changes in abundance very well (Matschke et al. 1994), probably due to a greater propensity for more than one animal to occupy a burrow system. On the other hand, two other indicators, one where the animal removes sword fern bundles from the burrow entrance and the other where the animal knocks down or moves a stick attached to the burrow floor, have been demonstrated by Engeman et al. (1991) to perform exceptionally well for assessing activity of mountain beaver (*Aplodontia rufa*) burrow systems. Both activity indicators also have been used successfully to monitor to for changes in populations.

Occasionally an investigator is faced with assessing the activity of a fossorial animal for which no prior information exists on assessment methodology. In these situations, methods that work for other fossorial animals can be applied, judged, and compared. This was the situation with which we were faced in southern Morocco during an ecotoxicity investigation into the environmental effects of two organophosphate insecticides used for locust control (Keith et al. 1994). That investigation required that several small mammal species populations be monitored within discrete areas before and after insecticide applications. The only population assessment method that we identified in the literature for the rodent species native to our study area was removal trapping (Zaime and Pascal 1988), which we could not apply when monitoring populations for a possible decrease. This paper presents information gained from the ecotoxicity study on methodology for assessing activity for three rodent species in southern Morocco.

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Table 1. Capture results for jirds (*Meriones* spp.) and fat sand rats (FSR, *Psammomys obesus*) in live traps in southern Morocco.

Trap period	Plot number	Trap-nights	Number of captures			Captures/trap-night		
			FSR	Jirds	Total	FSR	Jirds	Total
1	1	85	0	4	4	0.000	0.047	0.047
1	2	117	0	0	0	0.000	0.000	0.000
1	3	118	0	0	0	0.000	0.000	0.000
1	4	108	1	6	7	0.009	0.056	0.065
1	5	120	0	8	8	0.000	0.067	0.067
1	6	120	4	2	6	0.033	0.017	0.050
1	7	90	8	3	11	0.089	0.033	0.122
1	8	120	0	7	7	0.000	0.058	0.058
1	9	120	2	12	14	0.017	0.100	0.117
2	1	86	0	1	1	0.000	0.012	0.012
2	2	108	0	0	0	0.000	0.000	0.000
2	3	126	1	4	5	0.008	0.032	0.040
2	4	108	0	7	7	0.000	0.065	0.065
2	5	120	0	6	6	0.000	0.050	0.050
2	6	120	3	3	6	0.025	0.025	0.050
2	7	90	6	1	7	0.067	0.011	0.078
2	8	120	3	9	12	0.025	0.075	0.100
2	9	120	0	5	5	0.000	0.042	0.042

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MATERIALS AND METHODS

Study area

The environmental hazards study for which the activity assessment information was obtained was conducted 30 km northwest of Guelmime, Morocco, between the Ras et Tarf mountain range and Oued Assaka. The study area consisted of rolling hills, and narrow drainages with no perennial streams. The largest part of the area sloped to the north towards the Oued Assaka, while the southern part of the study area, on the south side of the Ras et Tarf divide, sloped to the south and east. Nine experimental plots, 1.5 km × 2.0 km with buffer zones of at least 700 m between them, were defined in this area for studying the effects of the aerially applied insecticides.

Vegetation in the study area was a daghmous steppe, an overgrazed, degraded state of an *Argania spinosa* climax dominated by *Euphorbia echinus* (Savage 1947). The study area supported only low bushes (seldom above 1 m in height) and a sparse ground cover of forbs and grasses. Only three plants were found in all of the study plots; *Euphorbia echinus*, *Senecio anteuphorbium*, and *Lycium intricatum*. During January and February, the months in which this study was conducted, daily maximum temperatures varied between 18° and 31°C, and nighttime minimums between 3° and 18°C.

Rodent species

The study area contained a variety of small mammals, but only two genera, both fossorial, occurred in sufficient abundance to be studied: Shaw's (*Meriones shawi*) and Libyan (*M. libycus*) jirds were common in certain areas as was the fat sand rat (*Psammomys obesus*). Shaw's jird is active in the night, and is commonly observed in the morning or late afternoon near its burrow. In open areas, burrows are found mainly near the base of trees or bushes. Shaw's jirds feed on green parts, fruits, and seeds of plants such as salsola (*Salsola vermiculata*) and *Euphorbia calyptrata*. Like other *Meriones*, they are great hoarders (Aulagnier and Thevenot 1986, Haltebourg 1968, Petter 1961). The Libyan jird is Saharan in distribution. Caches may be scattered throughout its burrow system from which it usually does not move very far. Like the Shaw's jird, this species feeds on and stores edible vegetation such as succulent plants, selected grains, cereals, or fruits. It is adapted to desert conditions and can survive on diets of only dry grains (Aulagnier and Thevenot 1986, Petter 1953, Petter 1961). Grain feeding and caching have made *Meriones spp.* significant agricultural pests in northern Africa (Fiedler and Fall 1994). The fat sand rat is mainly diurnal and lives in sandy areas. Its burrows have several entrances as well as food storage chambers and a nest chamber lined with finely cut vegetation (Aulagnier and Thevenot 1986, Nowak and Paradiso 1991, Petter 1952, Petter 1961, Petter et al. 1984). The preferred foods of the fat sand rat are primarily the leaves and stems of succulent plants of the family *Chenopo-*

diaceae, which contain a high proportion of water and salt (Zaime and Gautier 1989).

Assessment methods

The relative activity of rodents was evaluated in each of the nine 3-km^2 plots using both live trapping and the closed-burrow technique. Trap lines of Tomahawk live traps (12.7 × 12.7 × 40.6 cm) were placed in each plot where animals appeared to be the most abundant. Every 5–20 m along trap lines placed through areas of active rodent burrows, 2 traps were set within a 5-m circle, resulting in 30–45 traps per plot. Trapping points were flagged with surveyor's tape tied to the tallest nearby vegetation. Traps were baited with dates, apple slices and grains for jirds. Portions of local plants normally eaten by rodents, mostly salsola, were used for fat sand rats. Traps were set and then checked once in the morning and again in the afternoon for 3 consecutive days during both the pre- and post-treatment periods. All trapped rodents were ear-tagged, weighed, sexed, and released. The second live trapping session (post-treatment) was repeated on each plot 16–23 days after the first trapping session.

A closed-burrow assessment for activity of burrow systems also was applied within each plot, but such that the animals occupying the assessed burrow systems would be unlikely to be trapped. All burrow systems along a parallel route at least 50 m from the trap line were flagged and numbered, and all burrow openings were closed with dirt and small rocks. Marked burrow systems were checked 24 hours later and the number of closed burrows that were reopened was recorded without disturbing the burrows. Systems with one or more burrows reopened were designated as active, similar to the use of closed holes for designating northern pocket gopher burrows systems as active (Engeman et al. 1993). Burrow systems were checked again 48 hours after closure to examine whether the increased lag time would be more sensitive to burrow-opening activity of the animals. Each burrow system was considered an experimental unit for comparing 24 and 48 hour lag times.

The assessment by the closed-burrow method was repeated at a minimum interval of 16 days on each plot, except at this time only the burrows that were opened were the active ones identified as active in the first reading (inactive burrows had not been reopened by rodents during the first assessment). This allowed a comparison to trap success using a sample of all burrow systems (first session) and using the subset of systems identified as active in the first session (second session). Using the nine plots as experimental units, Pearson correlations were calculated between the closed-burrow results and the trapping results for each genera separately and both genera combined (the animal occupying a burrow system was not known with certainty for the closed-burrow method). It should be noted that between the two activity assessments on each plot, the insecticide treatments (6 plots) produced no detectable effects on rodent activity, nor on other vertebrates (Keith 1994).

Table 2. Correlations among live-trap capture rates for jirds (*Meriones spp.*) and fat sand rats (FSR, *Psammomys obesus*) with 24 hour closed-burrow (CB) results in southern Morocco. The 24 hour closed-burrow readings in period 1 used a random sample of all burrows, whereas the closed-burrow readings in period 2 involved only those burrows (and consequently burrow systems) that displayed activity in period 1.

	FSR	Combined	CB
	Period 1		
Jird	–0.066	0.726	0.118
FSR		0.638	0.130
Combined			0.181
	Period 2		
Jird	–0.177	0.698	0.172
FSR		0.581	0.182
Combined			0.274

RESULTS

In period 1 when burrow systems were randomly sampled 82 of 124 systems read as positive after 24 hrs. Seventy-six systems were also monitored 48 hrs after closure and none of the systems that were negative for activity after 24 hours read as positive after 48 hours. In period 2 when only the systems active (at least 1 burrow opened) in period 1 were tested (closed a second time), 3 of the 14 systems that read negative after 24 hrs became positive after 48 hours. Over the two periods, taking both positive and negative activity readings into account, only 3 burrows out of 150 (2%) had a 48 hour reading that differed from their 24 hour reading. We concluded that as a matter of time efficiency the 24 hr reading would be preferred. Hence, the 24 hour results were used for comparison to the trapping results.

Jirds were readily captured in the Tomahawk traps, but through trap shyness or smaller populations, fewer fat sand rats were captured, as is reflected in total captures and capture rates (Table 1). Correlations between trapping results of the two genera (*Psammomys* and both *Meriones* combined) were weak (Table 2). Weak correlations also were found between the trapping results for each genera separately and their combination (*Psammomys* and *Meriones* combined) with the closed-burrow results for the randomly sampled burrows, as well as when only the active burrows were used (Table 2).

DISCUSSION

Our motivation for applying population indices to the three species of rodents was for conducting an environmental assessment of locust insecticides applications. However, broader applications exists for indexing populations of these animals across northern Africa. In many areas these species are considered pests (especially *Meriones spp.*, Fiedler and Fall 1994) as they damage cultivated crops and irrigation structures, and have been implicated in the transmission of disease (e.g., Fiedler 1988, Nowak and Paradiso, 1991). Population index methods provide uncomplicated means for assessing the need and efficacy of control programs designed to address these problems.

As described earlier, the trapping locations within a plot and the closed-burrow activity readings were made at separate locations in the plots so that one measurement would not interfere with the other. However, because the same animals were not being measured, it is difficult to explain the low correlations between the closed-burrow activity measures and the trapping results. We could not relate trapping as an index to burrow opening within each species, because we could not identify with certainty the species occupying a burrow system. Responses to closed burrows may represent the population differently than the responses to baited traps. Also, responses by fossorial rodents to trapping probably vary more among species than do responses to burrow closure. If so, this would imply that without previous knowledge about trappability of a burrowing species, closure of open burrows might provide a more reliable first attempt at population activity assessment than catch rates for traps.

A rapid determination of activity is usually desired to maximize the efficiency of experimental resources and to minimize the effects of population fluctuations that may occur during the measurement process, especially in such situations where re-invasion may be rapid after a control method has been successfully applied. Because there was little difference between the 24 and 48 hour activity readings for the closed-burrow measure, it would appear that the 24 hour lag time between preparing (closing) and reading the results would be the most efficient to use, which is similar to findings for application of the open-hole method to northern pocket gophers (Engeman et al. 1993). However, if for a 24 hour reading a large proportion of burrow systems do not show activity (e.g., during unusual weather events), then another reading at 48 hours should be considered. This would be especially true if the number of systems being examined is small enough that a few changes from negative to positive would represent an important proportion. However, in a situation such as we describe, where a large number of burrow systems were inspected and a sizable majority of burrows showed a positive reading after 24 hours, then another reading at 48 hours would produce little change in results, and does not merit the additional effort.

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